

# Nonaccidental Head Injury in Infants

Shaken Baby Syndrome  
Shaken Impact Syndrome  
Abusive Head Trauma

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# Nonaccidental Head Trauma in Infants

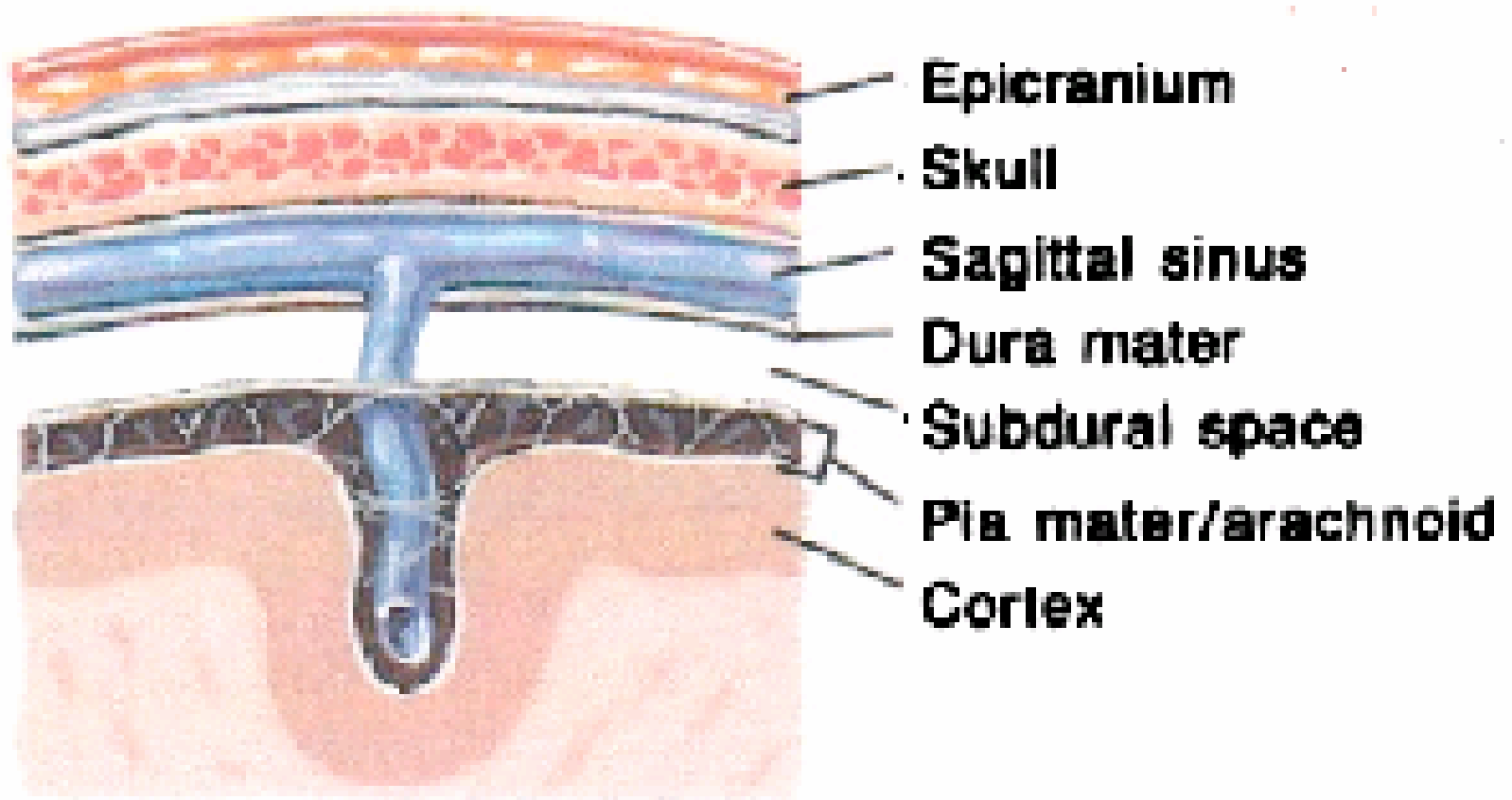
- Epidemiology
- Anatomy
- Mechanisms of injury
- Clinical presentation
- Differential diagnosis
- Medical work-up
- Outcome

# Head Trauma in Child Abuse

- Most common cause of mortality and morbidity in physical child abuse
- Intracranial injury – in 60% of inflicted injury deaths
- 33%-56% of brain injuries in children < 1 year of age were inflicted.
- >80% of deaths from head trauma in children under 2 are the result of AHT

# Anatomy of the Infant Head

A decorative graphic element consisting of a large, curved, light blue shape that originates from the left side of the slide and extends towards the bottom right corner, partially overlapping the dark blue background.



**Schema of bridging  
cerebral vein**

# Brain Parenchyma

- Neurons – basic cell of CNS
  - Cell body with nucleus
  - Dendrites – incoming impulses
  - Axons – outgoing impulses
- Gray matter – neuron cell bodies
- White matter – nerve bundles and tracts
- Blood vessels

# Infant Brain vs. Adult Brain

- Infant brain has approximately 25% more water than the adult brain
- Infant brain has little or no myelin

Result: infant brain is much softer, more gelatinous than adult and thus more fragile

# Shaken Baby Syndrome/ Abusive Head Trauma

- Violent shaking or shaking plus head impact against a hard or soft surface
- Many victims have evidence of impact, but not all
- Brain injury
- May or may not have eye injury, bone injury



# Abusive Head Trauma/ Shaken Baby Syndrome

- Usually under one year of age
- Can be up to 5 years of age
- 25% mortality
- Long term complications

# The Shaking

- Weak Neck Muscles
- Normal Large Head to Body ratio
- *Violent, sustained* shaking



# Intracranial Injuries

- Epidural hematoma
- Subdural hematoma
- Subarachnoid hematoma
- Parenchymal contusion, laceration
- Intraventricular hematoma

# Severe Axonal Injury

- Immediate Clinical Symptoms
  - Seizures
  - Unconsciousness
  - Breathing difficulty
  - Vomiting
  - Other signs of neurological damage

# Cerebral Edema (Brain Swelling)

# Other Brain Injuries

- Brain Laceration
- Brain contusion
- Parenchymal hemorrhage
- Spinal cord injury

# Extracranial Injuries

- Bruises (visible externally)
- Intra- and subcutaneous bruises (invisible)
- Lacerations
- Abrasions
- Subgaleal hematomas
- Alopecia

# Eye Injury

- Retinal Hemorrhages
- Vitreous Hemorrhage
- Retinoschisis
- Papilledema
- Retinal Detachment
- Disruption of eye contents



# Retinal Hemorrhages

- 50% to 100% incidence
- Unilateral or bilateral
  - Can be asymmetric
- Mild, Moderate or severe
- Described by:
  - Type
  - Location
  - Amount

# Retinal Hemorrhages

- Diffuse, severe, multilayered
- Extending to the retina's edge
- Not caused by
  - CPR
  - Seizures
  - Coughing and vomiting
  - Short Falls, minor head trauma
  - Elevated ICP
  - Vaccination
  - Most other diseases
- RH cannot be dated

# Bone Injury

- Rib Fractures
- Skull Fractures
- Long Bone Injury
  - Periosteal Stripping
  - Metaphyseal Fractures
  - Shaft Fractures

# Rib Fractures

- Single or Multiple
- Posterior and posterolateral
- Not caused by minor trauma
- Not caused by CPR
- Caused by squeezing

# Long Bone Fractures

- Bucket Handle and Corner Fractures
- Periosteal stripping
- Shaft Fractures
- Pulling and twisting forces
- Not common in blunt force trauma (except for shaft fractures)

# Constellation of Injuries

*The combination of characteristic  
injuries*  
= Shaken Baby Syndrome

# Outcome for Victims

- Retardation
- Learning Problems
- Seizures
- Hearing and speech Impairment
- Visual Impairment or blindness
- Behavior disorders
- Severe Brain Damage

# Missed Cases of Abusive Head Trauma (< 3 Years)

- 173 cases in 5 years
- 54 (31.2%) missed
  - Saw MD
  - Symptoms of head injury
  - Return and dx made
- Mean # MD visits before correct dx: 2.8 (range 2-9)
- Mean 7 days to dx (range 0-189)

From C Jenny, et al;  
JAMA: 281:621-626,  
1999



# Erroneous Diagnoses

## 54 Children, 98 Other Diagnoses

- **Gastroenteritis - 14**
- **Accident - 10**
- **R/O sepsis - 9**
- **Increasing head size - 6**
- **Otitis media - 5**
- **Seizure disorder - 5**
- **Reflux, apnea, URI, UTI, unknown bruising**

# Missed Radiographic Diagnoses

- 6 head CTs read as normal - + SDH
- 2 skeletal surveys - missed fx, periosteal reaction

# Better Recognition With More Severe Injuries

- Comatose
- Respiratory compromise
- Seizures
- Facial bruising

# Increased Risk of Missed Trauma

- **Younger age:** 180 days vs. 278 days
- **White race:** 37.4% white vs. 19% black
- **Family**
  - 2 parent : 40.2% missed
  - 1 parent 18.7% missed

# Clinical Presentation

- Swelling/bruising/fractures
- Vomiting
- Altered mental status
  - irritability
  - poor feeding
  - lethargy
  - unresponsive
- Seizures
- Apnea/ Found down
- Dead

# Injuries

- Head trauma
  - subdural hematoma
  - contusion
  - edema
  - skull fracture
  - subgaleal hematoma

# Injuries

- Alopecia (hair loss)
- Skeletal fractures
  - ribs
  - long bones - shaft, metaphysis
  - spine
- Bruises – external and internal
- Blunt abdominal trauma
- Sexual abuse injuries

# Differential Diagnosis – Intracranial Bleeding

## Accidental Head Trauma

- Short falls do not usually cause significant head trauma. (Exception: EDH)
- MVC and falls from  $> 10$  feet can cause intracranial injuries.
- Multi-layered RHs are seen almost exclusively in SBS/SIS.



# Short falls do not kill children

- Focal versus diffuse injury
- Shaking is often accompanied by impact
- Impact is not required for serious injury

# Other Causes of IC Bleeding

- Coagulation defects — usual sites for bleeding not intracranial but into joints, soft tissue
- Tumors — not easily confused with trauma
- Vascular malformations — rare, usually in brain tissue itself, not extraaxial space

# Obstetric Trauma

- Cephalohematomas
  - 3%-10% of newborns
  - 25% also have skull fractures
- Subdural hemorrhage
  - Associated with vacuum extraction
  - Chronic subdural collections may be associated with difficult deliveries, but social history and absence of associated injuries can usually distinguish them.

# Mechanisms of injury and their consequences

- Simple falls
- Shaking - acceleration/deceleration
- Stairs
- Impact
- Motor vehicle accidents
- Multiple story falls

# Medical Work-up

- History, if possible
- Physical exam
- Labs
- Radiography
  - X-rays
  - bone scan
  - head CT
  - head MRI
  - abdominal CT

# History

- History leading up to hospitalization
- Past history
  - hospitalizations, surgeries, ER visits
  - old injuries, fractures, significant bruising
- Family history
  - fractures, bone disease, bleeding, bruising
- Developmental history
  - see, hear, roll, stand, walk, talk

# Physical examination

- Mental status
- Skin trauma
- Skeletal trauma
- Abdominal trauma
- Head trauma
- Torn frenulum
- Retinal hemorrhage

# Lab and Radiographic Studies

- Head CT
- Skeletal survey
- Bone scan
- Head MRI
- Bleeding studies
- Chemistries - Ca, Phos, Alk phos



# Other Studies/Consultants

- Consultants

- Trauma surgeon
- Pediatric neurosurgeon
- Ophthalmologist
- Pediatric Intensivist
- Pediatrics/ Forensic Peds

- Sometimes consider:

- Urine Genetic Screen
- Copper
- Skin fibroblast culture
- Other as indicated
- Consultants
  - Medical Genetics
  - Developmental specialist

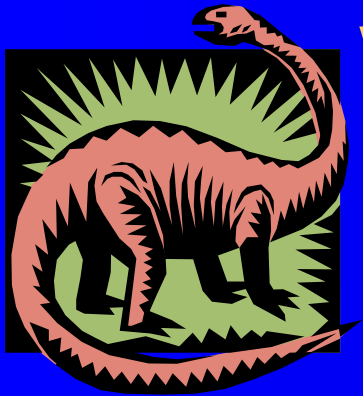
# Putting it Together – Multidisciplinary Evaluation

- Preliminary vs. later information
- Injuries present
- Timing of injuries
- Mechanism of injuries
- Plausible explanations
- Medical conditions
- Scene investigation

# Scene Investigation/ Other

- Witnesses - eye, phone,
  - incident
  - when child was last well
  - caretaking
- Scene condition
  - cribs, tables, stairs,
  - safety for baby, etc
- Criminal/CPS history

If children sustained lethal injury from everyday accidents, the human race would have been extinct long ago.



80% of deaths from head trauma in children under two years are the result of abusive head trauma.